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Description

LATERAL AND UPLIFT RESISTANCE APPARATUS AND METHODS FOR USE IN STRUCTURAL FRAMING

Cross Reference to Related Applications

[0001] This application claims priority from co-pending provisional application 60/486,664, filed July 11, 2003, by the inventor hereof, the entire disclosure of which is incorporated herein by reference.

Background of Invention

[0002] The present invention relates to support systems for framed structures, and more particularly to lateral and uplift resistance of structures made of light gauge steel or wood framing subject to dynamic lateral loads.

[0003] In general, the design of structural framing elements in buildings primarily addresses gravity loads. Gravity loads include static loads such as the weight of the building and the weight of attachments to the structure, as well as live

loads including the weight of human occupants, furniture, movable equipment, vehicles, and stored goods. In addition to gravity loads, structural framing design also must address dynamic lateral loads.

[0004] Dynamic lateral loads such as wind, earthquakes, vibrating machinery, temperature changes and long-term, gradual distortions due to shrinkage, creep, or settlement, involve special considerations. The principal application of these forces is in a horizontal, or lateral, direction. There are several conventional ways to provide lateral resistance for both light gauge steel framing and wood framing. A lateral force system may be provided by bracing systems that include, for example, diagonally or otherwise braced bays, rigid frames, and solid walls, called "shear walls". These three examples of bracing systems may be described as follows.

[0005] First, steel framing may include bays that are braced by cross-bracing, where two strips of metal are screwed to the front and back of the frame to make an "X." This is relatively inexpensive, but requires a high degree of skill to install without bumps or humps in the wall surface. This method results in an uneven wall because the strips protrude into the adjacent surfaces, particularly where

they are fastened to the framing. Further, it is very difficult to get the strips tight so that building flexure is minimized.

[0006] A rigid frame may include a rectangular metal frame with a cross member welded into it. Another type of rigid frame is a portal frame, which comprises vertical columns and horizontal spandrels mounted to the column and to the studs. The portal frame uses welded connections, and the column is commonly made of C-channels welded with stiffening plates for spandrels that are parallel to a lateral force. A portal frame is a custom design that requires attachment to a floor system or foundation. Both rigid frames are prefabricated and therefore do not allow field modification.

[0007] Shear wall panels may include a solid wall that is fastened on its periphery to each of the horizontal and vertical members. Rarely do these methods account for uplift force resistance, but in this application a cable may be used that is bolted to concrete at the foundation and passes through holes in the steel frame members in a crossing configuration. Moment-resistive joints may also be used, stiffening joints to prevent attached members from deflecting.

[0008] In addition to the methods discussed above, wood frames have long been braced by use of a diagonal member, such as a 1"x 4", notched, or "let in,"at each end to permit installation flush with the studs, often 2"x 4"s in residential applications. Uplift force is not considered, as there is no anchoring, and the frame can lift up off of a concrete base under extreme force. Structural sheeting material may be installed as a brace such as, for example, 7/16" oriented strand board, which is nailed across the studs. Rigid frames and shear wall panels may also be used to brace wood framing.

[0009] Only a few of the conventional systems provide for fastening to a foundation to resist uplift forces. Generally, except for the conventional method of wood bracing where a bracing member may be cut to fit, systems do not allow for on-site modification. Accordingly, there is a need for a bracing system that provides for resistance to lateral forces, uplift forces, or both. The system may be modular and adjustable at the construction site, requiring relatively little skill to install.

SUMMARY OF INVENTION

[0010] The present invention is directed to bracing apparatus and methods for structural framing made of light gauge steel

or wood. The bracing apparatus and methods may be used in resisting lateral forces, uplift forces, or both. The components may vary in dimension as required for use with a variety of framing member sizes. The bracing of the present invention, generally provided by two bracing clips and a tension strut of adjustable length, may be installed in framing bays of varying heights and widths.

[0011] A bracing clip is provided according to the present invention for use in resisting lateral and uplift forces exerted on light gauge steel members or wood structural framing members. The bracing clip includes two abutting rectangular plates that form a 90 degree interior angle. The two abutting plates may be formed from one bent plate. Each plate has a flange along each of the edges that is perpendicular to the plate and disposed away from the interior 90 degree angle. At least one bracket member plate disposed in the interior angle has one edge attached to the first plate and one edge attached to the second plate. Two parallel bracket member plates may be used. In another embodiment the flanges of one of the plates may be disposed towards the interior 90 degree angle.

[0012] In another embodiment, a stud support clip for supporting two vertically aligned studs is provided. The stud sup-

port clip allows a diagonal tension strut to pass between the two vertically aligned studs. The stud support clip includes a vertical central web portion having an interior major surface, exterior major surface, and a top end and a bottom end. Two inclined portions of the stud support clip extend away from the central web interior surface at an obtuse angle at each end of the web portion. A vertical terminal portion extends vertically away from each inclined portion and has an interior major surface and an exterior major surface corresponding to those surfaces of the central web portion. A first flange extends horizontally from each terminal portion vertical edge and forms approximately a 90 degree angle with the terminal portion interior major surface, and has an interior major surface and an exterior major surface. A second flange extends horizontally from each first flange"s free vertical edge and forms approximately a 90 degree angle with the first flange interior major surface. There are means for fastening the stud support clip to the vertical structural members and the diagonal tension strut. The stud support clip is adapted to receive a vertical structural member at each end and a diagonal tension strut between the vertical structural members.

[0013] In another embodiment, another stud support clip for supporting two vertically aligned studs is provided. The stud support clip includes two opposing central vertical web portions each including an interior major surface, an exterior major surface, and top and bottom ends. Two inclined portions extend away from each central web interior surface at an obtuse angle at each end of the respective central web portion. A rectangular sleeve extends from each of the inclined portions. Each sleeve is adopted to receive a vertical structural member, and the stud support clip is adopted to allow a diagonal strut to pass therethrough.

[0014] Other embodiments respectively provide bracing apparatus and a braced framing assembly for structural framing made of light gauge steel members, wood, or both. The structural framing includes first and second parallel, spaced vertical studs, each having an upper portion and a lower portion. There is a horizontal plate, which is a framing member, across the top of the two vertical studs and fastened to the upper portion of each stud. A sill is disposed along a base and fastened to the studs at the lower portion of the studs. A head clip is mounted to the horizontal plate and the upper portion of the first vertical

stud, and a sill clip is mounted the sill and to the lower portion of the second stud. An adjustable tension strut is provided, with means for mounting the tension strut to the head clip and to the sill clip. In another embodiment, the tension strut comprises two reciprocally mounted structural sections and means for fixing the length of the strut, whereby the length of the strut may vary according to the distance between the head clip and the sill clip. The head clip and sill clip may be as described above.

[0015] According to the present invention, the bracing apparatus and braced framing assembly may have bracket member plates that each have a hole therethrough that is aligned with a hole at each end of the tension strut, through which a fastener passes. Further, the sill clip may be anchored through the sill to the base such as, for example, concrete.

[0016] A method of making a bracing clip for use in resisting lateral and uplift forces exerted on structural framing members is provided, including providing a rectangular plate having side edges and front and rear edges. A first breakpoint line is identified at approximately the midpoint of the rectangular plate, from side edge to side edge, and perpendicular to the front and rear edges. Then the plate

is sheered along the breakpoint line an equal distance from each side edge of the plate until the remaining dimension of unsheered material along the first breakpoint line is approximately equal to the dimension of the framing member. Two second breakpoint lines are identified parallel to each side edge of the plate, passing through the point that is the extent of the sheering. The plate is broken along the second breakpoint lines to make four flanges all oriented in the same direction at approximately 90 degrees to the rectangular plate, and then is broken along the first breakpoint line to define first and second rectangular portions formed at an angle of approximately 90 degrees, with the flanges outward from the 90 degree angle formed around the first breakpoint. The bracing clip may have holes punched in it while the plate is flat, and bracket plate members may be welded to the first and second rectangular portions across the 90 degree angle.

[0017] Methods of bracing structural framing and constructing braced structural framing are also provided in accordance with the present invention. The structural framing includes parallel, spaced vertical studs, a horizontal plate across the top of the studs, and a sill along a base at the bottom of the studs. The horizontal plate is fastened to

the upper end of each stud, and to a sill fastened to the studs at the lower end of the studs. Head and sill clips are respectively mounted to the horizontal plate and the upper portion of the first vertical stud and to the sill and the lower portion of the second stud. A tension strut is adjusted to the desired length and is mounted to the head clip and the sill clip, and the length is fixed.

[0018] Features and advantages of the present invention will become more apparent in light of the following detailed description of some embodiments thereof, as illustrated in the accompanying figures. As will be realized, the invention is capable of modifications in various respects, all without departing from the invention. Accordingly, the drawings and the description are to be regarded as illustrative in nature, and not as restrictive.

Brief Description of Drawings

[0019] FIG. 1 is a front elevation view of a braced frame according to the present invention.

[0020] FIG. 2 is an exploded perspective view of bracing elements of the braced frame of FIG. 1.

[0021] FIG. 3 is an enlarged perspective view of the upper bracing elements of FIG. 2.

[0022] FIG. 4 is side elevation view of a head clip of the bracing

of FIG. 2.

[0023] FIG. 5 is a front elevation view of the head clip of FIG. 4.

[0024] FIG. 6 is a bottom plan view of the head clip of FIG. 4.

[0025] FIG. 7 is a side elevation view of a sill clip of the bracing of FIG. 2.

[0026] FIG. 8 is a front elevation view of the sill clip of FIG. 7.

[0027] FIG. 9 is a top plan view of the sill clip of FIG. 7.

[0028] FIG. 10 is a side elevation view of a nested tension strut of the bracing of FIG. 2.

[0029] FIG. 11 is a section view of the tension strut of FIG. 7 drawn along line 11-11 of FIG. 10.

[0030] FIG. 12 is a section view of the nested tension strut of FIG. 7 drawn along line 12-12 of FIG. 10.

[0031] FIGS. 13 and 14 are front elevation views of an installed stud support clip of the braced frame of FIG. 1.

[0032] FIG. 15 a perspective view of the stud support clip of FIGS. 13 and 14.

[0033] FIG. 16 is a side elevation view of the stud support clip of FIG. 15.

[0034] FIG. 17 is a front elevation view of the stud support clip of FIG. 15.

[0035] FIG. 18 is a front elevation view of the stud support clip of

FIG. 15 with cold-rolled channels added.

[0036] FIG. 19 is a front elevation view of a cold rolled channel of FIG. 18.

[0037] FIG. 20 is a top plan view of the cold rolled channel of FIG. 19.

[0038] FIG. 21 is a side elevation view of another embodiment of a sill clip according to the present invention.

[0039] FIG. 22 is a front elevation view of the sill clip of FIG. 21.

[0040] FIG. 23 is a top plan view of the sill clip of FIG. 21.

[0041] FIG. 24 is a perspective view of another embodiment of the stud support clip according to the present invention.

[0042] FIG. 25 is a side elevation view of the stud support clip of FIG. 24.

[0043] FIG. 26 is a front elevation view of the stud support clip of FIG. 24.

DETAILED DESCRIPTION

[0044] The present invention may be embodied in any application where structural framework requires resistance against lateral and uplift forces. Specific embodiments disclosed herein include the incorporation of bracing in framing made of light gauge steel or wood members. When fasteners or other means of attachment are required, it

should be understood that such terms refer to items such as screws, self-tapping screws, bolts, nails, welding, or like means known to one of ordinary skill in the art as applicable to metal or wood framing, unless otherwise noted herein. The scope of the invention is not intended to be limited by materials or dimensions listed herein, but may be carried out using any materials and dimensions that allow the construction and operation of the present invention. Materials and dimensions depend on the particular application.

[0045] In the Figures herein, unique features receive unique numbers, while features that are the same in more than one drawing receive the same numbers throughout. Where a feature is slightly modified between figures or similar features are in different locations, a letter may be added or changed after the feature number to distinguish that feature from the similar feature. Various parts may be described as having a "major surface." The major surface is a surface on a generally planar portion and represents the largest surface on the part or portion of the part. Further, certain terms of orientation are used, such as "upper,""lower,""left,""right,""horizontal,"and "vertical." These terms are generally for convenience of reference, and

should be so understood unless a particular embodiment requires otherwise.

[0046] Referring now to the drawings, FIG. 1 shows an embodiment of a framing and bracing apparatus 30 according to the present invention. Conventional framing components include vertical studs 32, 34, 36, 38, horizontal plates 40, 42, and a sill 44. Bracing apparatus includes a head clip 50, sill clip 50a, tension strut 54, and stud support clip 56. The head clip 50 is attached to the horizontal plates 40, 42 and the studs 32, 34, while the sill clip 50a is attached to the sill 44 and studs 36, 38. The head clip 50 and the sill clip 50a may be identical or substantially identical depending on the application. For example, in FIG. 1 they are substantially, but not exactly, identical because the head clip 50 attaches to two horizontal members, horizontal plates 40, 42, while the sill clip 50a attaches to the single member sill 44, and accordingly the dimensions vary. The tension strut 54 is bolted or otherwise fastened to head clip 50 and sill clip 50a. The tension strut 54, including two elongated web members 58, 58a, passes through stud support clip 56, which supports and is fastened to half-length studs 60, 62 that are respectively attached to the horizontal plate 42 and sill 44 in a

manner known to one of ordinary skill in the art. In one embodiment the head clip 50, sill clip 50a, and tension strut 54 are made of light gauge steel.

[0047] As shown in FIG. 2, the head clip 50 includes a horizontal portion 66 and a vertical portion 68. The horizontal and vertical portions 66, 68 may be made from a unitary piece of plate that is bent to a 90 degree angle, or may be separate pieces with an abutting and welded edge. For the purposes of description herein, a unitary piece of bent plate and separate but joined plates are considered to be equivalent. Flanges 70, 72, 74, 76 extend along the edges perpendicular to the 90 degree bend and away from the interior 90 degree angle, at 90 degree angles themselves relative to the respective horizontal and vertical portions so as to allow the flanges 70, 72, 74, 76 to fit around a structural framing member. Holes 78 through the flanges are provided for screwing or nailing the head clip 50 to the framing members. The head clip 50 further comprises a bracket 80 having two triangular bracket members 82, 84 mounted to the interior angle of the horizontal portion 66 and vertical portion 68. The triangular bracket members 82, 84 may be mounted by welding or other means of attachment known to one of ordinary skill in the art.

[0048] FIG. 3 shows an exploded view of an embodiment 30 of the present invention. The sill clip 50a is fabricated similarly to the head clip 50. In addition, one embodiment includes anchors 90 through the sill clip 50a, such as chemical or wedge anchors, to be placed into a concrete foundation. Such anchors 90 axially resist uplift forces.

[0049] The tension strut 54 has an adjustable length based on sliding, or telescoping, the web members 58, 58aand then fastening them using fasteners 96. Fastening of the web members 58, 58a to each other and to the triangular bracket members 82, 84 may be done with, for example, self-tapping screws, pre-drilled holes with screws or bolts as shown, or welding. As shown in FIG. 2, the upper end of the tension strut 58 is mounted to the bracket 80 of the head clip 50 by a bolt 98 that passes through holes 100, 102 in the triangular bracket members 82, 84 and through a hole 104 in the tension strut 54. The holes 100, 102 may be, for example, round, or slotted as shown. The lower end 58a of the tension strut 54 is similarly attached to the sill clip 50a.

[0050] The head clip 50 is shown in the side view embodiment 50 of FIG. 4 have a slotted hole 102 through bracket member 84 for attaching the tension strut 54 to the head

clip 50. A corresponding opening, slotted hole 100, penetrates the other bracket member 82 (FIG. 3). A slot 100, 102 may be used instead of a round hole in order to avoid compression force on the tension strut 54. As shown in the head clip 50 and sill clip 50a embodiments of FIGS. 4 and 7, when installed the tension strut 54 should be as short as possible, with the bolts 98, 98a on the edges of the slots 100, 100a and slots 102, 102a that are proximate to each other. When using this tension strut 54, it is necessary to ensure that the structure itself is "tight." Connections should be made in a manner to assure that they will be initially free of slack and will not loosen under load reversals or repeated loading. This means avoiding connections that are loose or that allow movement between the structural members. Avoiding loose connections is particularly important in systems subject to dynamic loading since relative movement between the structural members leads to increased wear and deterioration of the connection.

[0051] FIG. 5 and 6 respectively show a front view and a bottom plan view of the FIG. 4 head clip 50 embodiment. In this embodiment holes 106, 108 are shown penetrating the vertical portion 68, as well as holes 110, 112 penetrating

horizontal surface 66. Fasteners through these holes 106, 108, 110, 112 may be used to provide additional strength in the attachment to the horizontal plates 40, 42 or studs 32, 34 as applicable, or may be omitted.

[0052] Likewise, sill clip 50a is shown in the side view of the FIG. 7 embodiment 50a to have a slotted hole 102a through bracket member 84a for attaching the lower web member 58a of the tension strut 54 (FIG. 3) to the sill clip 50a. A corresponding slotted hole 100a penetrates the other bracket member 82a (not visible). FIGS. 8 and 9 respectively show a front view and a top plan view of the sill clip 50a. In this embodiment holes 106a, 108a are shown penetrating the vertical portion 68a, as well as holes 110a, 112a penetrating horizontal surface 66a. These holes 106a, 108a, 110a, 112a may be used to provide additional strength in the attachment to the sill or studs as applicable, or may be omitted. In particular, anchors 90 (FIG. 2) may be provided through holes 110a, 112a and into a base such as a concrete foundation in order to counteract uplift forces. The uplift forces will act along the axis of the anchors 90 as opposed to relying on the fasteners to the sill 44 through the flanges 70a, 72a that would encounter shear forces. The lower flanges 70a, 72a

of the sill clip 50a embodiment are not as deep as the upper flanges of the head clip 50 because the sill clip 50a is fastened to only one member, the sill 44, and the head clip is fastened to two members 40, 42.

[0053] The tension strut 54 is shown in a nested arrangement in FIG. 10. Upper portion 58 and lower portion 58a interlock with each other, and are reciprocally mounted. The shape of the members 58, 58a in this embodiment is a square C-member of FIG. 11, with one leg 114, 114a modified to be longer than the other leg 116, 116a. This allows the nesting shown in FIG. 12, and results in the telescoping relative movement of the members 58, 58a. The tension strut 54 is accordingly able to be installed in varying heights and widths of panels. Dimensions commonly encountered may be from eight foot to twelve foot height and two foot to five foot four inch width, although the present invention is not limited to these dimensions. An example size would be 1.5-inch by 1.5-inch C-member with the leg length adjustment made by not fully bending the curve 118, 118a of one leg inward to complete the "C." Alternative shapes may also be used, for example, a rectangular or square tube cross-section shape with one member sized to fit within the other member.

[0054] An embodiment of a stud support clip 56 is shown in FIGS. 13-17. As shown in FIGS. 13 and 14, the stud support clip 56 fits around the tension strut 54, with the ends of the stud support clip projecting vertically. Each end 120, 122 receives a portion of a vertical stud 60, 62 either metal or wood, which respectively extends and is fastened to the horizontal plate 42 or to the sill 44 as known to one of ordinary skill in the art. Each vertical stud 60, 62 and the tension strut 54 are fastened to the stud support clip 56 using fasteners 128 through holes 130, which may be punched, pre-drilled, or otherwise formed. Holes in all parts herein may be omitted in favor of self-tapping screws or the like.

[0055] Conventional spacing of structural framing studs 32, 36 is either 24 inches or 16 inches. Example spacing between studs 32, 36 (FIG. 1) is 48 inches. Accordingly, in order to provide intermediate studs for attaching sheetrock, sheeting, or other panels on exterior or interior sides at desired conventional intervals, one or more stud support clips 56 and associated studs 60, 62 may be provided. For example, in a 48-inch space, one support clip 56 would be needed to provide 24-inch spacing and two support clips 56 would be required to provide 16-inch spacing.

[0056] An embodiment of the stud support clip 56 is shown in detail in FIGS. 15-17. A web 132 is formed inward so as to meet the tension strut 54. Bent portions 134, 136 flare the web 132 outward to vertical portions 138, 140. First flanges 142, 144 each extend from a vertical edge of the vertical portions 138, 140 and form a 90 degree angle with the respective vertical portion 138, 140. Second flanges 146, 148 extend from the free vertical edge of each first flange 142, 144 to form a 90 degree angle. The flanges 142, 144, 146, 148 are sized and shaped to receive the portions of studs 60, 62.

[0057] As shown in FIG. 18, two channels 180, 182 which may be cold-rolled, are mounted to a stud support clip 56. The channels 150, 152 are used for additional support of a wall or sheeting, particularly in commercial installations. As shown in FIGS. 18-20, the channels 150, 152 include an elongated flat portion 153, 154 with a planar portion 155, 156 perpendicular to and at one end of the elongated portion 153, 154. Mounting holes 157 may be provided.

[0058] Another embodiment of a sill clip 50b is shown in FIGS. 21-23. The construction is similar to the sill clip 50a detailed in FIGS. 7-9. A general difference between the two

embodiments is that the flanges 160, 162 in the sill clip 50b of FIGS. 21-23 are bent upward rather than downward; the flanges 70a, 70b in the sill clip 50a of FIGS. 7-9 are bent downward. This embodiment 50b may be particularly useful for applying to steel framing.

[0059] FIGS. 24-26 show another embodiment of a stud support clip 170. The construction is similar to the stud support clip 56 shown in FIGS. 15-17. The stud support clip of FIGS. 24-26, however, has opposing vertical webs 172, 174. A tension strut 54 (not shown) passes through the opening between the webs 172, 174. Bent and angled portions 176, 178, 180, 182 flare outward from the opposing vertical webs 172, 174. A rectangular sleeve 184, 186 is provided at top and bottom of the clip 130 attached to the flared portions. Each sleeve 184, 186 receives a portion of a vertical stud 60, 62 (not shown) either metal or wood, which respectively extends and is fastened to the horizontal plate 42 or to the sill 44 as known to one of ordinary skill in the art. Each vertical stud 60, 62 and the tension strut 54 are fastened to the clip 170 using fasteners (not shown) through holes 188, which may be punched, pre-drilled, or otherwise formed.

[0060] The bracing of the present invention may be provided in a

variety of sizes. For example, the clips may be sized to conform to standard wood framing member sizes and standard light gauge steel framing sizes, or to larger or custom sizes. The tension strut may be sized in accordance with design considerations of a particular application. Further, a variety of connection means to the foundation could be used.

[0061] It should also be understood that not every feature of the bracing apparatus described is necessary to implement the invention as claimed in any particular one of the appended claims. Various elements of lateral and uplift force resistance arrangements may be used to fully practice the invention. It should also be understood that throughout this disclosure, where a process or method is shown or described, the steps of the method may be performed in any order or simultaneously, unless it is clear from the context that one step depends on another being performed first.

[0062] Specific embodiments of an invention are described herein. One of ordinary skill in the structural engineering arts will recognize that the invention has other applications in other environments. In fact, many embodiments and implementations are possible. For example, the brac-

ing of the present invention may be applied to other types of construction, and the securing of the tension strut may be used in other applications where lateral forces and uplift need to be resisted. In addition, the recitation "means for" is intended to evoke a means-plus-function reading of an element in a claim, whereas, any elements that do not specifically use the recitation "means for,"are not intended to be read as means-plus-function elements, even if they otherwise include the word "means." The following claims are in no way intended to limit the scope of the invention to the specific embodiments described.

[0063] What is claimed is: